COUNTER-UNMANNED AERIAL VEHICLE WARFARE: KILL AUTHORIZATIONS FOR THE CARRIER STRIKE GROUP

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

COUNTER-UNMANNED AERIAL VEHICLE WARFARE: KILL AUTHORIZATIONS FOR THE CARRIER STRIKE GROUP, by LCDR Joshua C. Mattingly, 76 pages.

Unmanned Aerial Vehicles (UAVs) are everywhere including the battlefields of Ukraine and Syria. Small UAVs are widely available, affordable, and expendable. Many countries and non-state actors use UAVs in an intelligence, surveillance, and reconnaissance role, but armed UAVs are becoming much more common. The United States leads the world in UAV employment including armed UAVs in an offensive role, but counter-UAV warfare is a new warfare area within the larger realm of air defense. Small Group 1 and 2 UAVs that weigh less than fifty-five pounds present a unique challenge for air defense because they are hard to detect, identify, and are being improvised for offensive roles. As small, armed UAVs become more prevalent, the U.S. Navy will encounter them with more frequency. Iran has already overflown the carrier strike group in the Arabian Gulf on several occasions. This thesis deals with the counter-UAV policy of when and where it is appropriate to shoot down or disable an adversary UAV in preemptive self-defense. The primary research question is: should rules of engagement allow for authorization of hard-kill and soft-kill options against UAVs for commanders in international waters, territorial waters, and international straights in peacetime? A UAV threat analysis and review of international law and UAV policy are included.

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ACRONYMS

A2AD	Anti-Access, Area Denial
CSG	Carrier Strike Group
DOD	Department of Defense
DOTMLPF-P	Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities, and Policy
EA	Electronic Attack
FAA	Federal Aviation Administration
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ISIL	Islamic State in Iraq and the Levant
ISR	Intelligence, Surveillance, and Reconnaissance
MALE	Medium Altitude Long Endurance
R&D	Research and Development
ROE	Rules of Engagement
SEAD	Suppression of Enemy Air Defense
UAS	Unmanned Aerial System
UAV	Unmanned Aerial Vehicle
UN	United Nations
VFR	Visual Flight Rules

CHAPTER 1

INTRODUCTION

Unmanned Aerial Vehicles: The Future Maritime Threat

Armed Unmanned Aerial Vehicles (UAVs) will be a major component of future war (Singer 2009, 110). They will be operated by states and non-state actors, and can be non-attributable. UAVs will combine autonomy and networked coordination to carry out swarm attacks (Scharre 2014, 14). Simple and cheap UAVs will be built in large numbers, and quantity has a quality all its own. Because they are unmanned and affordable they will be used against highly defended targets. Simply put, one of their qualities is that they are expendable. Additionally, they can use precision-guided munitions, which limit collateral damage. These machines will be able to maintain a high operational tempo and operate on a shortened decision cycle because of their artificial intelligence and lack of human limitations.

UAVs come in all shapes and sizes, from man-portable to enormous long-endurance drones such as the Global Hawk. They are able to conduct a wide variety of missions. Most military UAVs are utilized in an intelligence, surveillance, and reconnaissance (ISR) role. Several UAVs have been outfitted with offensive capabilities including the Predator and Reaper. There are fixed-wing as well as rotary-wing UAVs, such as Northrop Grumman's MQ-8 Fire Scout. UAVs have differing levels of autonomy. A fully autonomous UAV is able to make all decisions during a flight and interact with its environment without a human operator (Springer 2013, 2).

UAVs are manufactured and operated in many parts of the world. According to a 2014 RAND report, there are seventy countries operating UAVs and fifty developing

them (Davis et al. 2014, 9). In July 2013, the United States alone operated over 10,000 UAVs on a $3.8 billion budget for procurement and research and development (R&D). Worldwide, the budget for UAVs was $6.6 billion in 2013 and is projected to be $11.4 billion in 2022. Armed UAVs are proliferating. Twenty-three nations are developing them. The most capable armed drones are being developed in eight countries: China, India, Iran, Russia, Turkey, Taiwan, United Arab Emirates, and the United States. These Category I UAVs combine Medium Altitude Long Endurance (MALE) capability with Intelligence, Surveillance, Target Acquisition, Reconnaissance, and Attack functions. The most widely known UAV of this category is the General Atomics MQ-1 Predator. Three countries (Israel, Pakistan, and South Africa) are developing smaller MALE UAVs with a smaller payload. An example of this Category 2 UAV is the Iranian Ababil UAV, manufactured by Ghods Aviation Industries that has a 40-kilogram payload.

Today, the United States is proficient at offensive UAV operations, but counter-UAV capabilities are lagging behind. The United States will face adversary UAVs on the future battlefield. In the Ukraine, Russian-backed separatist forces use small drones for artillery targeting (Freedburg 2015). During the Second Lebanon War in 2006, the non-state actor Hezbollah used UAVs inside Israel. The Israeli Defense Force shot down two Iranian manufactured Ababil UAVs that were targeting an Israeli defense base (Johnson 2011, 92). As far back as 2002, Columbian troops seized nine model airplanes from the Revolutionary Armed forces of Columbia. The Revolutionary Armed forces of Columbia had planned to fill them with explosives and remotely fly them into government targets (Chamayou 2002).

UAVs present many challenges to counter-UAV operations and to the Carrier Strike Group (CSG). For one, they are difficult to detect. UAVs are typically much smaller than similar manned aircraft, presenting a reduced radar cross section. Additionally, they can operate low and slow. Even if their altitude permitted radar detection, their speed is insufficient for most radar systems to recognize them as aircraft and they are dismissed as clutter. Visually, UAVs are hard to detect for the same reasons, and because they are quiet. Advanced UAVs are incredibly maneuverable. Some advanced UAVs incorporate stealth technologies and others are entirely electric, making them especially quiet. Their low infrared signature can render an IR-guided missile useless against them.

UAVs could be used in many roles against the CSG. They are well suited for the ISR role and can provide over the horizon targeting. Suicide drones such as the Israeli Harop act as loitering munitions that wait until a pre-programmed radar signature is detected, then dive onto the source. Category I UAVs can carry out the entire kill chain process, from detection to battle damage assessment, against the carrier, although they are larger and more easily detected and engaged. Finally, UAVs operating in the vicinity of an aircraft carrier conducting flight operations are a safety of flight risk. Current UAVs cannot detect and maneuver to avoid collision with other aircraft around them.

Research Question

Research will address the current threat of UAVs. These small, commercial, off the shelf UAVs are affordable and readily available. Currently, in Eastern Ukraine, separatists are utilizing these drones for targeting and battle damage assessment. The U.S. military is the global leader in UAV operations, but counter-UAV operations represent a

gap in our capabilities. These UAVs are difficult to detect and track with current systems due to their size and flight characteristics. They can conduct a variety of missions including ISR, targeting, battle damage assessment, and strike. This is not just a military problem. The Federal Aviation Administration (FAA) and Secret Service have UAV issues as well, and would be a valuable source of lessons learned for the military. In today's environment, non-state actors are using militarized drones. Due to their size and sophistication, it is difficult to determine who their operators are. Some UAVs have been developed as loitering munitions or suicide drones. These UAVs normally do not identify themselves (with a transponder, for example), or monitor or establish communications. A captain of a U.S. Navy vessel could reasonably assume that a UAV could be controlled by anybody, and could be a first strike weapon. Moreover, a foreign UAV flying into the airspace around an aircraft carrier does not conform to any internationally accepted procedures or precautions for busy airspace. Last of all, it is important to remember that UAV capabilities will continue to increase. The primary thesis question is: should rules of engagement (ROE) allow for authorization of hard-kill and soft-kill options against UAV for commanders in international waters, territorial waters, and international straights in peacetime?

The following two subordinate research questions will assist in analyzing the topic in more depth:

1. Is there a reasonable expectation of safety for any aircraft approaching an aircraft carrier's active airspace when it cannot comply with "due regard" requirements for flight in international airspace (Convention on ICAO 2010, 3)?

2. Can protection of a high value unit from possible terrorist threats justify the pre-emptive destruction of foreign nation's unmanned assets?

Assumptions

This thesis relies on a few assumptions that will not be proven in this paper, but if they are not assumed, the conclusion of this thesis will be irrelevant or inconclusive. These assumptions will be treated as facts for the purpose of this thesis. The first assumption is that UAVs will continue to proliferate and develop as military weapons systems. The second assumption is that their frequency of use will increase. The United States, to this date, has not faced a serious UAV threat during hostilities. However, the potential exists making this research necessary and practical. A third assumption is that UAVs will be used asymmetrically. In the future, state and non-state actors will employ the autonomy of their UAVs to gain a tactical advantage over the United States.

Terms and Definitions

Terms used in this thesis are described below:

Artificial Intelligence: The ability of a computer or software program to emulate human cognition. Traditionally, artificial intelligence is achieved when a human could not distinguish between an artificial intelligence computer's response and that of a human (Springer 2013, 3).

Autonomy: Characteristic of a robot that can perform its function without human input (Springer 2013, 3).

Category 1 Unmanned Aerial System: A category of unmanned aerial system (UAS) defined by the Missile Technology Control Regime with the capability of delivering a payload greater than 500 kilograms to a range of at least 300 kilometers.

Category 2 Unmanned Aerial System: A category of UAS defined by the Missile Technology Control Regime with a range of 300 kilometers regardless of payload.

Drone: A machine that carries out pre-programmed actions with or without human interaction. They do not require sensors or artificial intelligence (Springer 2013, 2).

Group 1: The smallest category of UAS, weighing less than twenty pounds with a ceiling of 1,200 feet and airspeed less than 100 knots. They are typically launched by hand, man portable, and able to provide local surveillance via line-of-sight control. The RQ-11 Raven is an example (UAS Task Force 2011, D2-D3).

Group 2: The second smallest category of UAS weighing between twenty and fifty pounds, flying below 3,500 feet at a speed less than 250 knots. These small- to medium-size UAVs are typically catapult launched and provide ISR, targeting, and payload capabilities to brigade sized units. The Scan Eagle is an example (UAS Task Force 2011, D2-D3).

Group 3: The medium category of UAS weighs between fifty and 1,320 pounds, flying up to 18,000 feet at speeds less than 250 knots. They provide medium- to long-range capabilities flying from unimproved runways. The RQ-7B Shadow is an example (UAS Task Force 2011, D2-D3).

Group 4: The second largest UAS category weighing more than 1,320 pounds and flies up to 18,000 feet. They provide extended range and endurance capabilities and a

multitude of payloads, operating from paved runways. The MQ-1 Predator drone is an example (UAS Task Force 2011, D2-D3).

Group 5: The largest UAS category weighing over 1,320 pounds and operating at altitudes above 18,000 feet. These UAVs operate at medium and high altitudes with the greatest range and endurance. They can carry out many specialized missions including broad area surveillance and operate from improved runways. The RQ-4 Global Hawk is an example (UAS Task Force 2011, D2-D3).

Hard-Kill: A method for defeating an incoming threat by physical destruction or alteration. A hard-kill will impede a threat's intended effect.

Kinetic: A method of destroying a threat by hitting it with something like a bullet or an explosive.

Non-Kinetic: A method of destroying a threat without physically hitting it. Directed energy is an example.

Remotely Piloted: An unmanned vehicle whose flight controls are operated by a human.

Robot: Man-made devices with three components including sensors, processors, and effectors (Singer 2009, 67).

Robotic: Term describing machines with a partial ability to make decisions and interact with their environment. They require command and control from a human operator (Springer 2013, 2).

Rules of Engagement: Rules provided by a military authority setting the situations and limitations for use of force against an enemy.

Soft-Kill: A method of defeating an incoming threat by altering the target's electronic, acoustic, or other signature that alters the threat's tracking or sensing ability.

Unmanned Aerial System: All equipment associated with an UAV including airframe, command and communication equipment, launchers, recovery equipment, and sensors.

Unmanned Aerial Vehicle: An uninhabited aircraft.

Limitations

There are three limitations placed on the thesis prior to research. First, much of the current research and information on the UAV and counter-UAV topic is classified Secret and above. The research for this thesis is limited to unclassified and open source information. Second, research will use qualitative methods. Finally, single use weapons such as cruise missiles will not be included in the scope of this research. While many advanced cruise missiles have autonomous or robotic characteristics, they will not be considered UAVs. Some suicide UAVs, also referred to as loitering munitions, do share characteristics of a single use weapon, but they will be included in this thesis only if they have the capability of landing if munitions are not expended in an attack.

Scope and Delimitations

The scope of this thesis contains the UAV threat to the CSG and counter-UAV response. This thesis addresses the research question of whether or not hard-kill and soft-kill options should be authorized to commanders in their ROEs. Topics from the DOTMLPF-P framework (Doctrine, organization, training, material, leadership and education, personnel, facilities, and policy) for consideration are doctrine, policy, and

leadership and education. Research will include joint, interagency, and foreign considerations. While single use weapons may not be included as UAVs, the ROE discussions on their usage will provide a helpful reference. Counter-UAV methods will be discussed and not limited to systems currently fielded onboard U.S. Navy ships or organic to the CSG. The scope of this research simply covers protection for all CSG units from UAVs.

Significance of Study

Counter-UAV operations are a new warfare area for the U.S. Navy and Department of Defense (DOD) as a whole. Academic research and experts in this warfare area are limited in quantity. UAVs are a new threat. The United States has not faced adversary UAVs on the battlefield and U.S. Navy vessels have not been attacked by them yet. Perhaps CSGs underestimate the UAV threat because little is understood about it. Perhaps the current lack of organic counter-UAV systems lead to ignoring the problem. This topic is significant because a healthy discussion about whether or not a commander even has the right to shoot down a UAV should be held. This needs to happen because UAVs would be an appropriate weapon for an adversary to use for a surprise first strike attack (Jackson et al. 2008, 30). UAVs are hard to detect and do not put an adversary's life at risk in a highly defended environment. The United States is unaccustomed to countering them. If the Navy continues to lump counter-UAV operations in with traditional air defense, it runs the risk of taking the first hit in a war.

Additionally, a discussion on ROE authorization may lead to future requests for counter-UAV capabilities. If a commander has permission to shoot down or otherwise disable an adversary UAV, then he or she will want to have systems capable of detection

and engagement. Additionally, the specific type of authorization, whether it is hard or soft-kill, kinetic or non-kinetic would lead toward acquiring the appropriate systems.

Last of all, ROE could be used as a deterrent. A state or non-state actor may think twice about utilizing a UAV against the CSG if it is likely to be shot down. This in turn could help slow proliferation and/or development of these weapons. This discussion could also help shape internationally acceptable norms for use of UAVs specifically in the vicinity of warships.

Summary and Conclusion

In conclusion, UAVs represent a new threat that is becoming more and more capable. Future battle will certainly include adversary UAVs. Counter-UAV operations are a new warfare area that the DOD and the Navy must develop. A discussion should be held on what is acceptable for UAVs in and around a CSG. Determining how and when U.S. counter-UAV weapons systems will be employed is another important topic. A revolution in military affairs may have already begun concerning robotics, which includes UAVs. The military advantage of the United States in future conflicts could be decided by how well counter-UAV warfare is implemented.

CHAPTER 2

LITERATURE REVIEW

Organization

The literature review for this thesis is organized around four major topics. A summary of these topics will provide the necessary context and information to address the research question; should ROE allow hard-kill and soft-kill options for commanders in international, straights, and territorial waters in peacetime? The first broad topic concerns the current UAV threat. Second, what does the future hold for UAV warfare? The third topic discusses counter-UAV capabilities and methods. The last major topic in this literature review addresses legal and ethical issues, including whether or not UAVs should be banned weapons and a comparison of International Civil Aviation Organization (ICAO) laws for UAVs in international airspace and FAA laws on UAVs in the United States.

The news has covered many recent instances of UAV usage around the world. Many strategists have written about the future of warfare in the robot age. The United States leads the world in UAV R&D and employment; however, the world will catch up to the United States in the realm of robots including UAVs. The U.S. perspective on UAV warfare has been dominated by the role of the greatest user of this technology and the concept of air superiority. This literature review will provide context on how foreign actors are using UAVs and how the future threat environment will appear in order to better address the field of counter-UAV operations.

Current Unmanned Aerial Vehicle Threat

UAVs are not a theoretical threat to the United States and the Navy's CSG. They are present in every theater around the globe. A 2014 RAND Corporation report entitled *Armed and Dangerous? UAVs and U.S. Security* put global UAV procurement and R&D budget at $6.6 billion and projects growth to $11.4 billion by 2022. The report stated that as of 2014, there were seventy foreign militaries operating UAVs, fifty conducting R&D, and twenty-three countries with armed UAVs. The Missile Technology Control Regime classifies large and more capable UAVs as Category 1 and Category 2 for non-proliferation purposes. The highest category in this regime is Category 1. These UAVs combined Intelligence, Surveillance, Target Acquisition, Reconnaissance, and Attack with a Medium Altitude Long Endurance Capability (MALE). Category 1 UAVs can carry a 500-kilogram payload at least 300 kilometers. Eight countries including the United States, Russia, India, Iran, Turkey, Taiwan, United Arab Emirates, and China possess them. Category 2 UAVs have a range of at least 300 kilometers regardless of payload. Three more countries (Israel, Pakistan, and South Africa) possess them. There are twelve more countries with small payload and short distance armed UAVs (Davis et al. 2014, 9). Jack M. Beard sums up UAV missions in his journal article entitled, "Law of War in the Virtual Era," as carrying out the dirty, dull, and dangerous jobs. He also discusses the concept of "Virtual Distance." UAVs allow humans to be very far removed from the battlefield (Beard 2009, 1).

Iran has been very aggressive with their UAV development. Their Ababil UAV can carry a 40-kilogram payload and it has been exported to Venezuela and the non-state actor Hezbollah (Davis et al. 2014, 9). Hezbollah was the first non-state actor to use

drones offensively. Peter. Singer reports in his book, *Wired For War*, that three Mirsad UAVs were used to attack Israel in 2006. They were armed with twenty-two pounds of explosives and ball bearings (Singer 2009, 264).

Additionally, in 2011, Iran recovered an intact RQ-170 Sentinel, one of the U.S. Air Force's most advanced UAVs. It could have been sold to Russia or China for reverse engineering (Springer 2013, 26). As of 2014, Lieutenant Colonel Jason W. Early reports in his thesis, "The Effect of Adversary Unmanned Aerial Systems on the US Concept of Air Superiority," Iran had ten new drone designs including the Mohajer with a 50-kilogram explosive payload (Early 2014, 32).

Israel is among the biggest exporters of UAS. RAND reports them exporting UAVs to forty-two countries (Davis et al. 2014, 7). In his thesis, "The Children of Aphrodite: The Proliferation and Threat of Unmanned Aerial Systems in the Twenty-First Century," Major Darin L. Gaub notes a $400 million contract selling Searcher and I-bird UAS to Russia. Additionally Israel has sold UAVs to Turkey to assist their attacks on Kurdish Rebels (Gaub 2011, 37). Perhaps the most threatening of Israel's export UAVs is the Harpy. Manufactured by Israeli Aerospace Industries, the Harpy is considered a loitering munition. It is programmed to fly to a certain location and then search for a preprogrammed target like a specific radar signature. Once that signature is detected, it dives and destroys the target with its 70-pound explosive warhead. These UAVs have the capability of returning and landing if unexpended. Harpy was exported to China in 1994 (Gaub 2011, 35).

China has a very advanced and rapidly growing UAV program as well. They unveiled their first UAV concept at the 2006 Zhuhair Airshow. By 2010, the same

airshow showcased twenty-five UAV designs that resembled their western counterparts in appearance and mission (Guab 2011, 30). Major Gaub reports the Chinese stealth UAV, Dark Sword, can evade enemy radar while carrying out air-to-air or air intercept missions. Additionally, China has been converting old, first generation jet fighters into crude UAVs, which can be used as decoys in war, flooding and exhausting adversary air defense systems (Guab 2011, 35). Lieutenant Colonel Early also notes a Japanese P-3 witnessed a Chinese warship conducting integrated operations with a Group 2 UAV in April 2012 (Early 2014, 31).

Early also discusses India's and Pakistan's UAV aspirations. India has plans to operate 400 Group 1 and 2 UAVs and 100 Group 3-5 airframes. Pakistan, not to be outdone, currently operates the Group 2 Huma and Group 3 Eagle Eye (Early 2014, 32). Another UAV development mentioned in his monograph, "Effect of Adversary UAVs," occurred in Libya during their recent civil war. The National Transition Council, a rebel group, purchased a Canadian UAV named Scout from the Aeryon Company. This very capable surveillance drone cost $120,000 and is backpack portable, using a simple point and click map-based operating system. It has a day and night high fidelity camera, which was used to spot Libyan military artillery sites (Early 2014, 34).

Peter W. Singer brings another rebel use of UAVs to attention in his book. When the French Army deployed to the Ivory Coast in 2004, they did not take any air defense systems with them. The rebels contracted an Israeli intelligence firm to operate two Aerostar drones to pinpoint targets' global positioning system coordinates. The rebels also contracted ex-Red Army Belarusian pilots with Sukhoi fighters, which then used the GPS coordinates for strike missions. Nine French soldiers and one aid worker were killed

because of this arrangement (Singer 2009, 268). Another rebel group, the Revolutionary Armed Forces of Columbia, had nine remote control planes seized by government troops. Dennis M. Gormley sites this example in his occasion paper entitled *UAVs and Cruise Missiles as Possible Terrorist Weapons*, (Gormley 2003, 5).

Gormley goes on to discuss terrorist aspirations for using UAVs. He highlights Zacarias Moussaoli, the planner for 9/11 who was arrested with a crop duster manual. The plot's ring leader, Mohammed Atta, had visited a Florida crop dusting airfield in May 2000 and had attempted to secure a $650,000 Department of Agriculture loan to purchase a twin engine crop duster. Gormley notes several companies that sell UAV conversion kits for as little as $35,000 that can be installed into traditional aircraft (Gormley 2003, 7). Another terrorist plot that was foiled concerns a U.S. citizen named Rezwan Ferdaus, who was arrested in September of 2011. He had two remote control replicas of the F-4 Phantom and F-86 Super Saber, which were fitted with five pounds of plastic explosives and a global positioning system guidance system. His intended targets were the U.S. Capitol and the Pentagon (Early 2014, 31).

One can easily see how widely UAVs have spread and their applications are already numerous. There are two other ideas that should be summarized before moving on to a discussion of the future UAV environment. First, Major Gaub makes a point to compare current UAV development to World War I airpower. Gaub states that there were 1,000 airplanes at the beginning of World War I and 8,000 on the western front alone by the end of the war. They started out primarily conducting reconnaissance, and ended up bombing, strafing, fighting air-to-air battles, and spotting for artillery. Compared to Operation Iraqi Freedom, the U.S. Army started the conflict with fifty-four small UAVs

and had 4,000 by 2011 (Gaub 2011, 28). The second point comes from Lieutenant Colonel Jason Earley. He reminds the reader that the last time U.S. soldiers were attacked from the air was in Korea on April 15, 1953. The United States has enjoyed air superiority for over sixty years. Oddly enough, this last attack came from an antiquated PO-2. This single engine, fabric covered aircraft was designed by the Soviets in the 1920s and was so slow, light, and highly maneuverable that it was too evasive for U.S. air superiority assets (Early 2014, 1). This bears resemblance to the problems facing counter-UAV warfare today.

Future of Unmanned Aerial Vehicle Warfare

Peter W. Singer uses the term "Super Empowered Individuals" to describe how information and robots have created the possibility of Knowledge Enabled Mass Destruction (Singer 2009, 272). He argues that, in the future, one person could control UAVs and wreak havoc. Another concept he foresees is the use of mother ships to launch UAVs. An Ohio firm has already outfitted a C-130 to launch and recover UAVs from its rear cargo door. These mother ships allow for centralized control and dispersed firepower (Singer 2009, 227). Swarms of UAVs are described as well. These UAV swarms comprise highly mobile and individually autonomous machines working as a network akin to a wolf pack. Already the Santa Fe Institute has been experimenting with a system called PRAWNS (Proliferated Autonomous Weapons). This swarm system works on a decentralized control, concentrated fire concept. The machines would have diverse sensors, radio or infrared communications, automatic targeting algorithms, and would be equipped with various specialized weapons (Singer 2009, 232).

Paul J. Springer discusses several future concepts in his book *Military Robots and Drones*. First, he sees a role for autonomous UAVs in a Suppression of Enemy Air Defense (SEAD) role. SEAD UAVs would provide a cheap, low risk solution to exhaust enemy air defenses. Without a man in the loop, their fast reaction time gives them the advantage. Springer also postulates that the first nation to utilize their systems in a fully autonomous manner would be able to gain a short-term advantage. Having a man in the loop is becoming the limiting factor of system performance concerning time (Springer 2013, 51).

Perhaps the most thoughtful discussion on future UAV use in war comes from Paul Scharre's report, *Robotics on the Battlefield Part II: The Coming Swarm*. He foresees two paradigm shifts. First is the aggregate qualitative superiority of dispersing combat power over a greater number of platforms. By spreading out combat power, one increases force resiliency and diversity while increasing the cost of interdiction on an adversary. Second, he sees the human role as supervisory at the command level, overseeing multiple unmanned vehicles maneuvering and performing tasks autonomously (Scharre 2014, 6). Another future concept he explores is termed "Flash War" where opposing autonomous machines engage each other and their actions outpace the decision-making capacity of policy-makers (Scharre 2014, 7). Scharre also picks up on the swarm concept previously discussed in Peter W Singer. He argues that the side with superior algorithms powering their UAVs may have the upper hand against better hardware. He goes into further detail on swarms discussing their advantage in mass. A swarm of UAVs brings dispersed firepower, survivability in the form of swarm resiliency, graceful degradation of combat power (as opposed to losing combat power in large increments

when a capital ship is lost for example), and an ability to saturate enemy defenses. Leakers will always get through (Scharre 2014, 14). For the SEAD mission, Scharre mentions Miniature Air Launched Decoys and Miniature Air Launched Jammers. These tiny canister-launched UAVs would saturate enemy air defenses by presenting large numbers of expendable UAVs. The jammers would use EA against enemy sensors. He refers to this capability as an Electronic Storm (Scharre 2014, 15).

Counter-Unmanned Aerial Vehicles

Although the literature about counter-UAV operations is limited, the topic is diverse, not just covering capabilities. To start, there are different methods for dealing with the UAV threat. In the book, *Evaluating Novel Threats to the Homeland: Unmanned Aerial Vehicles and Cruise Missiles*, Brian A. Jackson delineates several of the hardships of countering UAVs. First, it is improbable to counter their proliferation. While high end UAVs may be controlled through international agreements such as Missile Technology Control Regime, small UAVs such as hobby vehicles are already widely available and simple to weaponize. Another technique for mitigating the UAV threat is for the target to react prior to attack, to hide or change position for example. This is difficult for two reasons. Small UAVs are incredibly hard to detect and, even if detected, they are hard to identify as a hostile UAV. Second, active defense has drawbacks. The identification process takes longer for small UAVs, allowing the UAV to close with the target. In addition, a UAV shooter has the burden of responsibility for where the debris lands. Another strategy for counter-UAV operations is pre-launch engagement. This is the use of indications and warnings as well as sensors to cue that an adversary UAV is about to

launch. This strategy requires a broad area detection capability as well as a geographically large engagement area (Jackson et al. 2008, 77).

In *Military Robots and Drones*, Paul Springer covers UAV vulnerabilities to non-kinetic methods. For one, their current reliance on human control makes them susceptible to jamming. For the same reason, they can be hacked to give an adversary control over the UAV. Another vulnerability is slightly different, signal interception. In 2009, it was discovered that Iraqi insurgents had used $30 software to intercept Predator video feeds. This enabled the insurgents to avoid detection and cued them in on what the United States was attempting to collect with their surveillance assets. Hacking can also subject a UAV to reprogramming. Once reprogrammed, a UAV could be commanded to attack the original programmer or destroy itself at a critical moment (Springer 2013, 48).

There have been some instances of success in counter-UAV operations. Lieutenant Colonel Earley highlights them in "Effects of Adversary UAVs." In 2008, Russian fighters were able to shoot down a Group 3 UAV operated by Georgia, an Israeli manufactured Hermes-450. In addition, in 2009, USAF F-16s successfully engaged an Iranian Ababil-3 UAV, which was operating six nautical miles inside of Iraq. These two instances were against Group 3 UAVs that were larger and faster than the more difficult to detect but simpler Group 1 and 2 drones. Additionally, it is easier to meet identification criteria for larger UAVs. Early does report that there is hope for tracking small UAVs, as a recent Joint Surveillance Target Attack Radar System upgrade has allowed the U.S. Air Force to track targets within a few thousand feet of the ground (Earley 2014, 39).

Additional counter-UAV capabilities are covered by P.W. Singer. Israel is fielding a system similar to the Close-In Weapons System called Skyshield (Singer 2009, 273). In addition, the Defense Advanced Research Projects Agency has an $11 million program called Peregrine. It is a loitering UAV killer, which circles at high altitude, detects, and then dives onto a target UAV. By placing your counter-UAV asset on your own UAV, Singer states that the defender reserves the "chance to shoot second," enabling an engagement after a hostile act is observed (Singer 2009, 398).

Finally, in Paul Scharre's *Robotics on the Battlefield Part II*, several forward-looking capabilities or methods are recommended. One idea is the use of unmanned missile barges by a fleet. These automated barges would house a multitude of air defense munitions and would relieve existing warships the risk of going "Winchester" which is running out of ammunition (Scharre 2014, 15). Another recommendation is the usage of a counter-swarm against swarming enemy UAV formations. To succeed, a counter swarm must simply be more affordable or have more effective programming. Scharre discusses EA as well. EA attack can be applied over a wide area. If a swarm is subjected to EA that disrupts their networking capability, they cannot coordinate and their effectiveness devolves into a melee engagement. EA can also badly confuse a UAV. Autonomous machines' cognition lacks the human capacity for common sense. If UAVs operate on fake data, they can fail badly (Scharre 2014, 42). Another way of thinking about this concept is that rudimentary artificial intelligence has a hard time distinguishing between an apple and a tomato, which are both roughly the same shape and color, but vastly different. Scharre also sees how invaluable low cost-per-shot weapons such as high-energy lasers and electromagnetic rail guns may be to future counter-UAV operations

(Scharre 2014, 51). To summarize, there are serious hardships to overcome when attempting counter-UAV operations as well as obvious UAV vulnerabilities. There have been instances of success in this warfare area, and new, more advanced counter-UAV weapons are being developed. However, even with the capacity to engage a UAV, is preemptive self-defense a defensible course of action?

Legal Considerations

There are two legal topics to review here. First, are UAVs legal? There are several different arguments for banning certain types of UAVs. Second, what do ICAO laws have to say about operating aircraft, including UAVs, in international airspace? In addition, how does this compare with FAA regulations concerning UAVs in the United States?

Grounds for Banning Unmanned Aerial Vehicles

Jus in Bello is the term for just conduct in war. *Jus in Bello* includes the concepts of proportionality, discrimination, and accountability (Singer 2009, 382). Many experts do not believe autonomous and remotely piloted UAVs can comply with the proportionality requirement to limit collateral damage to what is necessary to achieve the military objective (Sparrow 2011, 702; UNIDR 2015, 7). There is doubt concerning their ability to limit civilian deaths. Additionally, autonomous robots cannot understand the finality of death and cannot make an ethical decision on how much civilian death is acceptable (Springer 2013, 53).

Experts also assert that autonomous UAVs cannot comply with the requirement for discrimination in *Jus in Bello*. Discrimination means that non-combatants must not be targeted. The Second Pillar of International Humanitarian Law prohibits weapons that

cannot discriminate (Singer 2009, 384). International Humanitarian Law Article 48 Additional Protocol I requires parties to armed conflict to distinguish between civilian people and property and military people and objects (UNODA 2015, 25). Another aspect of discrimination is that people are no longer combatants if they surrender. Additional Protocol I, Article 41 of the Geneva Convention requires that *hors de combat* shall not be made the object of attack. *Hors de combat* is a condition where combatants have clearly expressed a desire to surrender, abstain from hostile acts, and do not attempt escape (Sparrow 2011, 704). A robot must not only be able to determine who is or is not a combatant, but also must be able to read the intentions of someone trying to surrender. Will a UAV break off an attack when someone drops their weapon or leaves cover? Experts agree that autonomous robots will be unable to determine surrender for decades (Sparrow 2011, 712; Singer 2009, 383).

Similar to the requirement to grant surrender is a prohibition on orders to give no quarter or take no prisoner. Additional Protocol I Article 40 of the Geneva Convention forbids no survivor policies in combat and threatening adversaries with no survivor policies. The Hague Regulations Article 23(d) prohibits the no quarters given order (Sparrow 2011, 704). Since small UAVs do not have the capacity to accept prisoners, employing them in combat is akin to releasing a weapon that cannot grant quarters (Sparrow 2011, 722).

The last concept associated with *Jus in Bello* is accountability. For international laws to be effective, those who violate them should be punished. Who is accountable when an autonomous UAV violates the Laws of Armed Conflict? Unaccountability could violate the Fourth Pillar of International Humanitarian Law that bans weapons too

difficult or abhorrent to deal with. The answer of who is accountable is murky. The only way to preserve accountability is to keep a man in the loop (Singer 2009, 407).

Even having a man in the loop of a semi-autonomous UAV's kill chain is simply not enough for many people since autonomy is a spectrum (UNODA 2015, 47). A semi-autonomous UAV possessing a long duration where an attack cannot be recalled is considered to be on a long leash, meaning less than ideal human control. The launch of an armed UAV operating on a long leash would be a hostile act (Sparrow 2011, 722). An example of this would be Israel's autonomous Harpy. Several groups have called for meaningful human control over armed robots. They include the Human Rights Council, Convention on Certain Conventional Weapons, civil society campaigners, and experts. The United Kingdom accepted non-governmental organization Article 36 requiring meaningful human control over attacks (UNIDR 2014, 2). They recognized that mobile autonomous weapons need a higher level of human control to adhere to International Humanitarian Law requirements for distinction and proportionality.

While on the subject of man in the loop and meaningful human control, it matters who is operating the UAV. Civilians operating armed UAVs can be considered illegal combatants according to the Laws of Armed Conflict and their employment in this role could encourage reprisals against civilians (Klein 2004). Several experts believe that using civilian operators of weapons during an armed conflict is illegal and immoral (Rogers and Hill 2014, 77; Singer 2009, 407). Good intelligence would be required to correctly identify civilian operated armed UAVs. A commander could argue that he has the right to destroy the weapon of an illegal combatant.

An area of international law quite applicable to this research question is codified in the *San Remo Manual San Remo Manual on International Law Applicable to Armed Conflicts at Sea*. The *San Remo Manual* is a contemporary compilation of existing customary international law. One provision states that civilian aircraft operating in the vicinity of a warship shall comply with combatant instructions for heading and speed. Just as small Group 1 and 2 UAVs cannot fly under instrument flight rules because they lack two-way communications, they would not be able to comply with these orders from warships broadcast on guard frequencies (International Institute of Humanitarian Law 1994, para 131).

The arguments for banning armed UAVs are numerous and convincing. It is obvious that UAVs are currently not fully compliant with international laws as a weapon due to technological limitations. However, the international community has tolerated their use for several years now, and they may be considered acceptable under customary international law. Some people argue that UAVs offer a more humane way of fighting war. The recorded video from UAVs is like an unblinking eye that provides evidence for legal review of attacks, increasing transparency (Beard 2009, 439).

International Civil Aviation Organization

The Chicago Convention is the constitution for the ICAO, laying out internationally accepted aviation rules and regulations for flying in international airspace. This constitution has been joined by 190 contracting states (ICAO 2010). Within the Chicago Convention, Article 12 requires civil aircraft to operate in compliance with either the laws of the state where the aircraft is being flown, or according to Annex 2's Rules of the Air when operating in international airspace, which is airspace over the high

seas. The Rules of the Air only apply to civil aircraft, but the Chicago Convention does make a distinction for state aircraft in Article 3 (Marshall 2009, 700). The only definition or guidance on what constitutes a state aircraft is that they are public aircraft operated by the state including military, customs, or police aircraft (Ells 2014, 347). Article 3 of the Chicago Convention does instruct that state aircraft shall not fly in the territory of another state without authorization from that state and shall fly in accordance with the terms of operation with that state (Marshall 2009, 699). The Chicago Convention does address civil unmanned aircraft. Article 8 prohibits unmanned aircraft flight within a state without the state's permission. With permission, the unmanned aircraft must comply with the state's terms for authorization. The state is responsible for ensuring control of the unmanned aircraft to prevent danger to other civil aircraft (Marshall 2009, 699).

Federal Aviation Administration

The FAA has been working on plans for integrating UAVs into the national airspace. Their recently published unmanned aircraft regulations are more restrictive than those of the ICAO. Additionally, the FAA distinguishes between commercially operated UAVs and model aircraft or UAVs operated by hobbyist. 49 U.S. Code § 40102(a)(6) defines unmanned aircraft as aircraft (FAA 2016, 2). Additionally, 14 Code of Federal Regulations § 91.13 prohibits all aircraft from careless or reckless operation that endangers the life or property of others.

14 Code of Federal Regulations § 1.1 defines model aircraft as devices capable of sustained atmospheric flight, flown within visual range, and for hobby or recreational purposes. There are several regulations concerning model aircraft. They must be flown lower than 400 feet above ground level and within visual range of the operator. They

must remain well clear and give way to manned aircraft. They shall not be flown within five miles of an airport without contacting that airport and complying with mutually agreed upon procedures. UAVs are not to be flown near people or stadiums. They shall weigh less than fifty-five pounds. A new requirement is for model aircraft to be registered according to Section 336(c) of Public Law 112-92 (FAA 2016, 2). The aircraft shall display a registration number and the operator must carry a registration certificate. Additionally, all UAVs must comply with Notice to Airmen and Temporary Flight Restrictions. These are time critical notices and restricted areas. A permanent drone no-fly zone exists within a 30-nautical mile radius of Ronald Regan Washington National Airport in Washington, DC.

Last of all concerning FAA regulations, the 2012 FAA Modernization and Reform Act section 336(b) gives the FAA legal enforcement obligations when UAVs endanger the safety of national airspace (FAA 2016, 3). Clearly, laws in the United States are much more comprehensive and restrictive than ICAO regulations about UAVs, and are evolving to integrate them into the national airspace. This contrast highlights how outdated ICAO regulations are for UAVs today. The failure to account for current UAV technology in international airspace is a safety concern.

Summary

UAVs are everywhere. This technology is proliferating at a great rate. Small UAVs are so prevalent that there is no hope of limiting who owns them. They are easy to arm. The future should be a scary thing to ponder considering the vast potential for UAVs in the coming years. Robots will be making decisions autonomously much faster than a human can. Existing defenses would be quickly saturated. Counter-UAV operations are

in their infancy. This warfare area must play catch-up and cannot be ignored. There are many arguments for banning UAVs. Can they comply with requirements for proportionality and distinction? ICAO regulations on UAVs are quite limited compared to FAA laws. Overall, the rules for using UAVs and engaging them must still be resolved.

This thesis serves the purpose of contributing to a discussion on policy concerning the use of UAVs and defending one's own unit from the UAV threat. It is helpful to first consider what counter-UAV methods are suitable for the purpose of self-defense. Then a comprehensive UAV policy should be created to enable the practical application of counter-UAV doctrine. This policy would be helpful in guiding the U.S. DOD's conduct of UAV operations and serve to deter potential adversaries with regards to their use of UAVs against the United States.

CHAPTER 3

RESEARCH METHODOLOGY

Method

Chapter 3 addresses the research method used to define the problems associated with counter-UAV operations and find the answer to the primary research question. To answer the primary research question, whether or not commanders should be authorized hard and soft-kill options in countering UAVs, a qualitative research method will be used. This study focuses on the necessity for kill authorization of adversary UAVs based on a threat analysis. This thesis also explores the legality of UAV operations in international waters and justification for preemptive self-defense for exercising this authorization. Research seeks to confirm or deny justification of shooting down a non-U.S. drone.

The qualitative method of research employing archival review is specifically useful for the counter-UAV topic because it is a new warfare area and there is more conceptual literature than data and practical experience on the topic. A comparison of modern UAV usage will provide contextual understanding. Comparing and contrasting current approaches to counter-UAV both within and outside the U.S. Navy, or the DOD more broadly, should be applied when suitable to highlight different policies for countering UAVs. In addition, analysis of historical situations may provide context and precedent for legal arguments.

This thesis study will contain four major areas in a broad to narrow framework. In the archival review reoccurrence of concepts in different sources will be combined. First, the current and anticipated small (Group 1 and 2) UAV threat will be analyzed with a

focus on the CSG as the target of an adversary attack. Second, research will be conducted in order to answer the first subordinate research question: is there a reasonable expectation of safety for any aircraft approaching an aircraft carrier's active airspace when it cannot comply with due regard requirements for flight in international airspace? The third section will attempt to answer the second subordinate research question: can protection of a high value unit from possible terrorist threats justify the pre-emptive destruction of foreign nation's unmanned assets? Lastly, specific situations where there are grounds to allow preemptive self-defense against UAVs will be determined based on the research behind the subordinate questions and the threat analysis.

Defining the Problem

The first major research area in chapter 4 contains two parts which help define the UAV threat. First, research was conducted regarding the reasons for using UAVs over other methods of attack against the CSG. This illuminates likely scenarios where they will be used, and what types of UAVs concern the CSG the most. UAVs have their own benefits and limitations. Past employment is analyzed to provide examples of situations where they were used. This section provides background and situational awareness for subsequent steps toward answering the research question.

Secondly, a more in-depth threat analysis of current and future state and non-state operators of UAVs is conducted which builds upon chapter 2's broad illustration on the UAV threat. The purpose of this threat analysis is to define the capabilities of adversary UAVs so that counter-UAV methods can be evaluated for suitability and feasibility.

Determining Legal Justification

The second and third major research areas focus on determining the legality of both UAV operations in international waters and preemptive self-defense against UAVs. These approach the legal question from two directions in order to answer the primary research question. The second major research area addresses the first subordinate research question, covering the concepts of see and avoid and due regard.

The third major research area addresses the second subordinate question about preemptive self-defense. A qualitative archival review provides depth and breadth in the legal areas of self-defense, preemptive self-defense, and terrorist employment of UAVs. Some historical context is provided to understand past precedents.

Interpreting Requirements

Aircraft carriers operating overseas find themselves in three different modes of operation: international waters, strait transit, and territorial waters. These different modes of operation are distinguishable from one another because of the different international laws applying to warships in these situations. In this fourth major area of chapter 4, counter-UAV methods suitable to each distinct mode of operation are applied, keeping the likely adversary UAV threat in mind from the first section. UAV hard-kill or soft-kill methods are selectively applied to situations warranting an ROE authorization. These situations for kill authorization are selected based on the research from the two subordinate questions for legality, acceptability, and suitability.

Summary and Conclusion

Chapter 5 summarizes the findings of this project's research, painting a clear picture of the UAV problem. This chapter explains how this thesis relates to past research on the topic and provide recommendations for future study. U.S. Naval vessels provide the enemy an enticing target for terror or first attack due to their constant forward presence as well as their strategic and psychological value. It is important that UAV policy and counter-UAV doctrine help the U.S. Navy avoid taking that first punch from an adversary. Allowances should also be made to factor in the growth and maturation of UAVs and more generally robots in the future battle space.

CHAPTER 4

ANALYSIS

Organization and Purpose

Chapter 4 is organized in a broad to narrow framework. The first major research area is a continuation of information presented in chapter 2 concerning the UAV threat but focused on the specific threat to the CSG. The purpose of this carrier-specific threat analysis is to provide context for a follow-on determination of recommended ROE. The second major research area addresses the first subordinate question: is there a reasonable expectation of safety for any aircraft approaching an aircraft carrier's active airspace when it cannot comply with due regard requirements for flight in international airspace? This question serves to aid in research regarding the primary research question and provides a different perspective in determining the legality of UAV operations in international airspace. The third major research area addresses the second subordinate question: can protection of a high value unit from possible terrorist threats justify the preemptive destruction of foreign nations' unmanned assets? Here research becomes even more specific pertaining to the concept and legality of preemptive self-defense for the CSG against UAVs. This research area also serves the purpose of supporting the primary research question. The last major research area will address the primary research question: should ROE allow for authorization of hard-kill and soft-kill options against UAVs for commanders in international waters, territorial waters, and international straights in peacetime? A coherent answer to this policy question is the ultimate goal of this thesis.

The Unmanned Aerial Vehicle Threat to the Carrier Strike Group

Adversary UAVs present a unique and emerging threat to the CSG. This chapter begins with a more detailed, and CSG specific, analysis of the UAV threat prior to answering the research questions. This threat analysis is the first major research area of the thesis. The reason for starting here is because any commander's decision to preemptively defend their unit from armed attack must be made on the basis of necessity. The nature, magnitude, and likelihood of a threat must be weighed before acting. Also, this threat analysis is focused solely on the smallest UAVs, Group 1 and 2, because larger UAVs are very similar to manned aircraft. The big UAVs can be detected, tracked, and identified much more easily due to their larger size and faster speeds of operation (Earley 2014, 38). Small Group 1 and 2 UAVs are a distinctive and elusive threat because they are harder to detect and identify, and do not carry transponders (Early 2014, 38; Director Joint Staff 2012, I-7). Many experts agree that these weapons lower the threshold for use of force since there is no risk of the user's personnel being killed or captured (Kreps and Zenko 2014, 68; Streetly 2015, 41). This section consists of three areas. First will be an analysis of situations advantageous to the use of UAVs. The second section analyzes current and likely use of adversary UAVs by state actors. Third, non-state actors' UAV current and likely use is analyzed.

For context, before covering the three sections listed above, it is important to report a very recent situation where a UAV overflew two aircraft carriers. On January 12, 2016, the Iranian news agency, FARS, released a surveillance video from an Iranian Shahed 121 UAV of the USS *Harry S. Truman* and French aircraft carrier, *Charles De Gaulle*. The location of this event was eight-nine nautical miles south of the Iranian Port

of Bushehr. The Associated Press also obtained U.S. Navy footage of the drone through a Freedom of Information Act request. The drone was visually reported wings clean, meaning it was not carrying weapons. Additionally, FARS reported a Qadir-Class submarine operating in the vicinity and collecting intelligence. The act was characterized as a propaganda stunt (Gambrell 2016). The author of this thesis also experienced an Iranian UAV over flight of USS *Harry S. Truman* during a U.S. Central Command deployment in 2014. Clearly, as these events demonstrate, the UAV threat is not hypothetical, and encounters with CSGs will continue and increase in frequency as UAVs become more numerous and sophisticated.

Advantageous Situations

This first section of the UAV threat analysis regarding the CSG covers situations conducive to UAV use. For a small UAV to be selected as the weapon of choice by an adversary, it must have an advantage over other weapons for the particular situation. By determining situations advantageous to UAV use, likely scenarios of UAV employment can be predicted. UAVs are well suited for "dull, dirty, or dangerous missions" (Beard 2009, 1). In other words, in certain cases, it is better not to use a manned asset. Due to the limited payload and capability of small Group 1 and 2 UAVs, their utility is limited and only advantageous for a set of niche situations.

First, UAVs are suitable for attacks over perimeter defenses, an example of a dangerous role. These situations include mobile defended targets and targets surrounded by water, which describes carrier operations precisely (Jackson et al. 2008, 30). Organic aircraft and an accompanying ship such as a cruiser or destroyer primarily defend

carriers. UAVs due to their size and difficulty of detection can skirt these defensive units and attack directly at the carrier.

Another situation advantageous to the use of UAVs is conducting simultaneous surprise attacks (Davis et al. 2014, 12). Some adversaries are limited in their manpower. UAVs can mitigate this limitation by safeguarding personnel, replacing them with technology. Simultaneous attacks are beneficial when fighting a CSG because the element of surprise would be lost after the first incident. Follow-on strikes risk discovery and compromise. Additionally, simultaneous attacks are more desirable because when their effects are combined they are magnified into a large, more noteworthy event. Some actors, such as terrorist organizations, would also benefit from the prestige of coordinating a sophisticated attack in this manner (Jackson et al. 2008, 42).

UAVs are also useful for sustaining campaigns, or series of attacks. The size and portability of small UAVs mean operators can easily disperse and hide after attacks, reducing the risk of apprehension and enabling them to fight another day. These series of attacks can have a psychological effect, instilling terror in the targets, hurting moral. Additionally, the adversary operating the UAVs benefit from increased credibility simply because they have continued the offensive (Davis et al. 2014, 12). As a campaign of attacks progresses, the defender will expend disproportionate numbers of assets to counter the UAV threat (Jackson et al. 2008, 48).

Another benefit of being dispersible and concealable is that UAVs advantageous for conducting attacks across national borders. An adversary can attack from inside or outside the border of the target state or adversary state. This makes the attacker harder to attribute, and consequentially more difficult to retaliate against (Jackson et al. 2008, 37).

In this situation, an attacking UAV could also operate from maritime platforms such as boats or oil rigs.

Attacking a symbolic target is another situation where UAVs are beneficial (Davis et al. 2014, 14). Small UAVs with conventional weapons cannot hope to sink or completely disable an armored warship, but aircraft carriers are considered a symbol of a state's military power. An attack on an aircraft carrier, no matter how small, would be a symbolic attack aimed directly at the military might of the United States. Also, small UAVs are cheap, widely available, and easy to manufacture in great numbers. These characteristics make them expendable. Their expendability and lower risk of use make them an attractive policy alternative (Davis et al. 2014, 15).

There are two more situations that UAVs excel in over other weapons platforms. One is very serious and the other conceptual. First, UAVs are ideally suited for dirty missions such as attacks with biological or chemical weapons. Should the attacker lack access to pilots or planes, a UAV offers a simple alternative for dispersal of such agents (Jackson et al. 2008, 52). Studies have shown that UAVs offer a stable platform and are ten times better for dispersal of aerosol agents than missiles (Gormley 2003, 5). Last of all, UAVs can be utilized at various levels of autonomy. As UAVs become more sophisticated and as artificial intelligence strengthens, the day will come when UAVs may be used in a fully autonomous mode. In a fight between two parties, the side that elects to employ robots autonomously first will have a short-term advantage from a reduced decision cycle as a result of taking the man out of the loop (Springer 2013, 51).

To review, the situations advantageous to usage of small UAVs include attacking over a perimeter defense, conducting simultaneous surprise attacks, sustaining a

campaign of attacks, and attacking over borders. They are also particularly useful for attacking symbolic targets, employing chemical or biological spray agents, and in situations where the speed of autonomy could provide the upper hand against countermeasures. All of these roles would be appropriate when attacking an aircraft carrier.

State Actors

The next two sections of this CSG specific UAV threat analysis make a distinction between current and likely uses of UAVs by state and non-state actors. State actors will be covered first. As stated in chapter 2, there are twenty-three countries developing or operating armed UAVs (Davis et al. 2014, 9). Here the threat analysis focuses on the countries of China, Iran, and Israel in warfare areas of anti-access area denial (A2AD), SEAD, and covert operations.

First, China has a very robust UAV program, possessing some of the most sophisticated drones in the world. Their UAVs are capable of MALE and intelligence, surveillance, target acquisition, reconnaissance, and attack missions (Davis et al. 2014, 9). In 2012, a Japanese P-3 Orion watched a Chinese warship conduct operations with a Group 2 UAV (Earley 2014, 31). Sea launched UAVs increase the likelihood that CSGs will encounter UAVs, and extends the distance from land where they can operate. China's concept for operations in the eventuality of conflict in the South China Sea is based on the idea of A2AD, where it can dissuade a potential adversary from approaching their coast, giving them regional sea control. China will likely develop autonomous UAVs because they suit this mission (UNIDIR 2015, 4). These UAVs will likely be

assigned orbits off the coast where they can loiter autonomously and independently complete the kill chain in their sector when the need arises.

Next, Iran has a very active UAV development program with ten new small and medium size UAVs. The Quds Mohadjer 4 can carry fifty kilograms of explosives and under-wing rocket-propelled grenades. In addition to being well armed, it can fly up to 18,000 feet, with a range of eight-one nautical miles, and operate for seven hours (Streetly 2015, 73). Additionally, a U.S. F-16 shot down an Iranian Ababil-3 UAV with a 45-pound warhead six nautical miles inside of Iraq in 2009, demonstrating that Iran will fly armed drones within the airspace of foreign nations (Early 2009, 38). The newer version, Ababil-T, is capable of carrying a 100-pound high explosive warhead and can fly up to 14,000 feet and can be controlled up to twenty-seven nautical miles away (Streetly 2015, 73). This UAV has been provided to Hezbollah, which named it the Mirsad. This demonstrates that Iran has provided armed UAVs to non-state or terrorist organizations. Iran continues to use UAVs in an ISR role, to support non-state actors, and as previously mentioned for harassment and propaganda purposes. Iran is expected to use UAVs in an A2AD role in the Strait of Hormuz if armed conflict occurs.

Israel is one of the biggest exporters of UAVs in the world. They have pioneered the use of UAVs for SEAD missions. In the Yom Kippur War, Israel used drone waves to seduce Egyptian air defenses. Once the Egyptian anti-aircraft batteries were Winchester or out of ammunition and missiles from shooting at drones, Israel followed up with manned aircraft attacks. In addition, in 1982 in the Bekaa Valley of Syria, Israel used drones to activate Syrian air defenses in order to locate them for later strikes (Chamayou 2015, 27). As far back as 1994, Israel developed a specialized UAV named Harpy for

SEAD. It is a considered a loitering munition. The Harpy is pre-programmed to seek out a discrete radar signal, then launched to a suspected area up to 270 nautical miles away where it searches for that signal, then hones in on and dives to destroy the emitting array with a 70-pound warhead. Israel exported this UAV to China (Gaub 2011, 35). The newest version is called the IAI Harop and has a six-hour endurance and satellite communications data link (Streetly 2015, 92). Experts agree with Israel that UAVs are perfect for SEAD missions because they are a low risk solution with fast reaction times. Additionally, the UAVs used cost less than the air defense missiles expended to shoot them down (Springer 2013, 51).

The last situation in this state use of UAV threat analysis concerns covert operations. Most armed UAVs are used by states' covert armed forces such as the Central Intelligence Agency in the United States. In this mission area, there is less transparency about strike criteria and the covert nature of the missions make accountability harder. UAVs are attractive in this mission because of the difficulty in attributing their usage. This makes situations more difficult for policy makers and the media to learn what happened after an attack. A review of the legal framework is also more difficult (UNODA 2015, 44).

Non-State Actors

Non-state actors include terror organizations, criminal groups, and other organizations not representative of a country and can operate in an inter-state manner. These groups operate small UAVs such as hobby or commercial UAVs because they are cheap and easy to obtain. Larger classes of UAVs are prohibitive to these groups because they are more technically difficult to use. Due to their low cost, organizations can afford

to use many small UAVs against multiple targets (UNODA 2015 45). In the future, terrorist organizations are expected to use UAVs as an alternative to suicide to carry out a directed attack. Terrorist personnel live to fight another day. Additionally, a captured drone cannot be interrogated for intelligence (Singer 2009, 269).

Hezbollah has had success with UAVs. In 2006, Hezbollah was the first non-state organization to use armed UAVs when they attacked Israeli targets with Mirsad drones carrying 221 pounds of explosives (Singer 2009, 264). In 2014, Hezbollah carried out an armed UAV attack on the Al-Nusra Front resulting in twenty-eight deaths (Bunker 2015, 12).

Several non-state organizations have shown interest in using UAVs for chemical and biological weapons dispersal. In 1994, the Aun Shinrikyo cult experimented with remote control helicopters for the purpose of a saran gas attack. Their helicopter crashed during testing (Bunker 2015, 7). Additionally, one of the terrorists who planned the 9/11 attacks, Zacarias Moussaoli, had crop dusting manuals and had inquired about getting a $650,000 loan from the Department of Agriculture for a prop driven crop duster. Several companies offer UAV conversion kits for these types of aircraft starting at $35,000 (Gormley 2003, 5-7).

A non-state actor does not need an armed UAV to carry out an attack. There have been many reports of near mid-air collisions between aircraft and UAVs. Aircraft are most vulnerable to a deliberate attempt at collision when they have just taken off and are slowest and heaviest. They could also be used on short approach to land. In both these instances the location of the attack is fixed. Non-state actors could use small UAVs

individually or as a coordinated swarm to carry out such an attack (UNODA 2015, 46). The applicability of this threat to aircraft carriers as floating airfields is clear.

Non-state actors do not have to be organizations. These attacks can come from individuals as well. There are no examples of individuals using armed UAVs for attacks, but a recent incident involving the White House should serve as an indicator of vulnerability and what is possible. On January 26, 2016 an employee of the National Geospatial Intelligence Agency flew a commercially available off the shelf, DJI Phantom, UAV from his apartment several blocks away to the south lawn of the White House where it crashed into a tree in what was characterized as a "drunken lark" (Shear and Schmidt 2016). It occurred on a cold and rainy morning at three o'clock, demonstrating the ability for a small and relatively simple UAV to be flown during under conditions of low visibility and adverse weather. It was also reported that radar systems designed to detect planes, missiles, and larger drones did not detect it. The UAV was detected visually by an officer before it crashed.

Finally, the inter-state terrorist organization Islamic State in Iraq and the Levant (ISIL) is becoming more adept at using UAVs. On April 17, 2016, An Iraqi soldier reportedly shot down an ISIL DJI Phantom drone. ISIL had been using UAVs for propaganda, surveillance, indirect fire spotting, and weapons delivery. This was the fifth time in thirteen months that coalition forces reported destroying an ISIL drone. On April 3, 2016 an improvised UAV was shot down, proving that ISIL was modifying existing drones. In December of 2015, Kurdish rebels reported downing an ISIL UAV with an explosive payload (Schehl 2016).

Threat Review

To review the small UAV threat concerning the CSG, UAVs are beneficial for a myriad of situations. They also are quite capable for specific mission roles. The low observability of small UAVs allows them to overcome perimeter defenses and strike the carrier. UAVs allow for simultaneous attacks and prolonged campaigns of attacks, serving as a force multiplier for actors with limited personnel. Concealment of operations is another beneficial characteristic allowing for non-attribution of attacks or covert operations. UAVs can provide a psychological or moral victory for an actor against a symbolic target. Slow and low, the small UAV is an ideal platform for chemical and biological weapons employment. UAVs will also have the unique ability to operate in a fully autonomous mode, allowing for quick reaction.

State actors have developed UAVs for specific mission sets. China will use autonomous UAVs to carry out the full kill chain in an A2AD strategy at sea. Israel has been successful with UAVs for SEAD. Iran really focuses on small, armed UAVs for ISR and strike. As a state sponsor of terrorism, they also provide armed UAVs to non-state actors. The most widespread use of armed UAVs has been for states' covert operations.

Last of all, non-state actors are limited to the small Group 1 and 2 UAVs for practical reasons. They utilize them for spotting and small strikes. These groups have been innovative in modifying hobby and commercial UAVs. Many groups are interested in combining UAVs with chemical and biological weapons. It is important to note that individuals are empowered to carry out attacks with UAVs. Lone wolf attacks are a real possibility.

In conclusion, aircraft carriers have already encountered UAVs on the high seas and should anticipate a growing threat. Not only are UAVs capable, they are simply better weapons in certain roles and circumstances. A commander should be fully cognizant of the UAV threat in their area of operation in order to make the time critical decision to defend his unit.

Due Regard and See and Avoid

The second major area of research for this thesis concerns whether a UAV can operate legally with due regard or is capable of complying with the aviation safety principle of see and avoid. Here the first subordinate question in this thesis is addressed. Is there a reasonable expectation of safety for any aircraft approaching an aircraft carrier's active airspace when it cannot comply with due regard requirements for flight in international airspace? Can a UAV fly through an aircraft carrier's airspace during flight operations without the ability to see and avoid or comply with due regard requirements? Before moving to the next subordinate research question which deals with justifying shooting down UAVs in preemptive self-defense, it is helpful to know if UAVs operate legally when flying since they have no onboard pilot responsible for safety of flight. Not only is there no pilot, but there is a time lag between the operator's input and the UAV's response. Conversely, operators using streaming video from the UAV for control are seeing a time late image, so in actuality there are two time lags when controlling UAVs (Chamayou 2015, 74). Another factor to consider is that video streamed from a UAV has the field of vision of a soda straw (Rogers and Hill 2014, 72). Humans have the capability of using their peripheral vision that greatly enhances collision avoidance because the hard to detect threats of collision do not approach from the center of focus.

International Civil Aviation Organization

The Rules of the Air according to ICAO Annex 2 stipulate requirements for the operation of civil aircraft under visual flight rules (VFR) when the weather is clear and the pilot can see, and instrument flight rules (IFR), when the pilot cannot see due to bad weather or night conditions. The rules state that while VFR the pilot in command is responsible for following the Rules of the Air including the principle of see and avoid. See and avoid is also known as detect and avoid and is an ICAO obligation for pilots to be on the lookout for other aircraft and take actions to avoid collision (Ells 2014, 342). While IFR a civil pilot is required to receive traffic separation from an Air Traffic Control authority that uses radar to keep aircraft separate, or collision hazard information from an Air Traffic Separation authority when outside of radar coverage (Marshall 2009, 703).

The Rules of the Air do not apply to state aircraft including military, police, or customs aircraft. Article 3 of the Chicago Convention does instruct that state aircraft shall not fly in the territory of another state without authorization from that state and shall fly in accordance with the terms of operation with that state (Marshall 2009, 699). Another requirement for state aircraft operating in international airspace is Due Regard. This is a shortened term which means state aircraft shall operate with due regard for the safety of all air and surface traffic. A pilot of a state aircraft operating under the principle of due regard is responsible for their own separation from other traffic and the safe conduct of the flight. Concerning state aircraft, the Chicago Convention makes no distinction between manned and unmanned aircraft (Marshall 2009, 705).

Since unmanned aircraft are still considered aircraft within the Chicago Convention, civil unmanned aircraft must still comply with the see and avoid principle when operating in international airspace while VFR. While IFR unmanned aircraft are still obligated to not operate negligently or recklessly as to create a collision hazard. They are also not permitted to operate close to other aircraft (Marshall 2009, 707). In order to comply with see and avoid, an unmanned aircraft must have a technical capability to detect and avoid other aircraft either on board, from a ground based system, or from a pilot in command operating the aircraft. Beyond line of sight control, unmanned aircraft operating in international airspace require a degree of artificial situational awareness (Ells 2014, 328).

Experts believe that ICAO regulations are inadequate concerning unmanned aircraft and their unique differences (Marshall 2009, 698). Since no airborne detect and avoid system is certified by any civil aviation authority to replace human ability, unmanned aircraft cannot comply with the Rules of the Air requirement to see and avoid when operating under VFR beyond line of sight from the operator (Marshall 2009, 711). The definition of state aircraft under Article 3 and the lack of distinction for unmanned aircraft is so vague that it is the hardest factor for determining what aircraft are allowed to operate under the principle of due regard. In conclusion, with respect to ICAO regulations, UAVs do not operate legally unless they are IFR and provided separation from other aircraft from a controlling agency, or are operated by a controller via a clear line of sight under VFR in international airspace. Therefore, a small UAV flying around an aircraft carrier in international airspace and beyond the sight of its operator would be in violation of international law whether classified as civil or state.

Review

The answer to the question of whether there is an expectation of safety for an aircraft approaching an aircraft carrier's airspace when it cannot comply with due regard requirements for flight in international airspace is no. There is no expectation of safety for an aircraft, including UAVs, which cannot provide their own safe separation. All aircraft, manned and unmanned, civil or state operated, are required under international law to fly safely. This means they must not cause mid-air collisions or harm people and property. In international waters a UAV must be flown VFR with the help of an operator who can ensure safe operation from visual line of sight since there are no artificial systems capable of replacing a human pilot's ability to see and avoid. A work around is to fly the UAV IFR with control or advisory from a controlling authority capable of providing safe separation. However, this control requires two-way radio communications with the controlling authority and a transponder. Even if small UAVs did carry this additional equipment, they are so small that normal air search radars will not reliably see them. The inadequacies of ICAO regulations concerning UAVs are numerous and become glaring when compared to the FAA's updated and restrictive regulations.

Preemptive Self-Defense against Unmanned Aerial Vehicles

The third major area of research concerns preemptive self-defense of the CSG against UAVs. The subordinate research question addressed here is: can protection of a high value unit from possible terrorist threats justify the preemptive destruction of foreign nation's unmanned assets? The first section of this major area of research covers the concept of self-defense. Next, the concept of preemptive self-defense will be covered,

taking note of its development over time. Third, research addresses the use of preemptive self-defense against UAVs operated by terrorist.

Self-Defense

Just war theory's roots includes work by a seventeenth century jurist named Hugo Grotius who wrote *De Jure Belli ac Pacis* about the laws of war and peace. It was broken down into two parts, *Jus ad Bellum* about the act of going to war and *Jus in Bello* about the conduct of war (Singer 2009, 382). United Nations (UN) Article 51 addresses *Jus ad Bellum* and justification for use of force. According to Article 51, states may use force under a UN resolution or in self-defense (Sofaer 2003, 212). This article affirms the right to individual or collective self-defense if an armed attack occurs. Armed attack is significant force against the armed forces of another state operating abroad, whether on land, sea, or air (UNODA 2015, 21). Article 51 goes on to require self-defense adhere to the principles of necessity and proportionality, and be an immediate response (Henderson 2010, 140).

Necessity for self-defense is determined if force is only used when non-forcible measures do not work, are infeasible, or have been exhausted (UNODA 2015, 23). Necessity should account for the nature and magnitude of the threat, and the likelihood of the threat occurring (Sofaer 2003, 220).

Proportionality means that force used in self-defense should not exceed what is required to stop an attack or prevent continuing attacks (UNODA 2015, 23). Joint Publication 3-01, *Countering Air and Missile Threats* states that proportionality is the force required to respond decisively and that the nature, duration, and scope of self-defense should not exceed that requirement (Director Joint Staff 2012, III-11). Finally,

self-defense of one's unit is an inherent right and obligation in response to a hostile act or demonstrated hostile intent (Director Joint Staff 2012, III-10).

Preemptive Self-Defense

Preemptive self-defense, also referred to as anticipatory self-defense, is a situation where a unit believes it will be attacked by an adversary, and elects to use force first to counter the threat before it has fully developed into an armed attack. Preemptive self-defense is allowed under special circumstances. The first appearance of preemptive self-defense in legal argument comes from a historic event known as the *Caroline* Incident, named after the American ship involved. On December 29, 1837, British troops boarded the ship in American waters, killed the Americans, set fire to the *Caroline*, and set her adrift over Niagara Falls (Henderson 2010, 172). The *Caroline* had been continuously supplying Canadian separatists in their fight against the British Government. U.S. Secretary of State Daniel Webster issued a statement in 1842 in response to the Caroline Incident that has become widely accepted customary international law regarding preemptive self-defense.

Daniel Webster's statement on preemptive self-defense in another state's territory is based on the imminence of an armed attack. This means that the attack to be preempted would be instant, overwhelming, and leaving no time for deliberation (Streetly 2015, 24; Sofaer 2003, 214). Webster justified the preemptive self-defense attack by the British because the United States had not fulfilled a duty to use police powers within their own border to prevent the *Caroline* from aiding the Canadian separatists. Determining imminence can be determined based on relevant facts including nature and immediacy of the threat, probability, part of a series of attacks, scale of the attack or the resulting injury,

loss, or damage from an unmitigated attack, and the likelihood of future opportunity for self-defense when less damage will occur as a result (Bethlehem 2012, 6). Some lawyers disagree with Webster and believe anticipatory self-defense can only occur on the territory of the defending state.

Webster's rule is a narrow exception to Article 51. Most international lawyers interpret Article 51 as only allowing for self-defense after an attack has occurred (Sofaer 2003, 2014). Webster's rule was used and upheld by the UN as a basis for blockade during the Cuban Missile Crisis. The rule was also rejected on three occasions: when cited by Israel in the Six-Day War, after the USS *Vincennes i*ncident, and when Israel preemptively destroyed Iraq's Osiraq nuclear reactor (Henderson 2010, 176). Some experts argue that Article 51's two categories authorizing the use of force are too limited for the modern age with terrorism and rogue states and incapable of regulating use of force as it stands (Sofaer 2003, 212). In a situation where weapons of mass destruction are the instrument of first use of force, Article 51 certainly should not apply.

One event really crystalized the naval need to use preemptive self-defense. In 1967, an Israeli destroyer, the *Eilat*, was sunk by a single Styx anti-ship missile from an Egyptian patrol boat. Before the attack on the *Eilat*, naval commanders believed they could absorb the initial armed attack, survive, and then act in self-defense. Since then, commanders have an obligation to detect hostile intent as a demonstration of imminent armed attack (Bunn 1986, 336). Examples of hostile intent include activation of fire control radars or uncovering of missile batteries. Because hostile intent is determined subjectively, commanders traditionally are only authorized first use of force against an

imminent attack on their own unit, or unit self-defense; all other first use of force authorization is reserved for the national command authority (Bunn 1986, 325).

Due to the evolution of weapons technology some experts believe the right to self-defense should evolve and mature as well. As defense options narrow or become more unlikely to work, acceptability of preemption has grown. Secretary of State Condoleezza Rice argued that new technology requires up to date assessment of when a threat becomes imminent (Schmitt 2003, 534). This assessment should balance the state's right to exist unharmed, and the international community's need to minimize destabilization from use of force.

According to President George W. Bush's administration, Webster's limiting rule on preemptive self-defense is outdated because defeat from a devastating blow can happen instantaneously (Schmitt 2003, 534). Engagements last only seconds now and it is hard to determine the intentions, location, tactics, and targets of transnational terrorist organizations. Schmitt said, "Clausewitzian fog of war has thickened dramatically in the context of the new war against terrorism" (Schmitt 2003, 534). Bush's 2002 *National Security Strategy* announced the intention of the United States to exercise preemptive self-defense against terrorist, the rationale being that any delayed self-defense from waiting for a threat to fully materialize would be too late (Henderson 2010, 180). Operation Iraqi Freedom was the first test of this policy based on faulty intelligence reporting weapons of mass destruction inside Iraq. No weapons of mass destruction were found and the policy ended up looking bad (Henderson 2010, 182). Nonetheless, the 2006 *National Security Strategy* reaffirmed the right for preemptive self-defense. Allies did not object to this policy, but they did not adopt it either (Henderson 2010, 192). A UN study

in 2015 stated that preemptive self-defense doctrine is justified if the self-defense occurs during the last window of opportunity to effectively prevent an armed attack (UNODA 2015, 25).

When weighing preemptive self-defense it is interesting to consider that UAVs are machines and nobody dies when they are destroyed. Two authors have argued that robots do not have a right to self-defense (Singer 2006, 406; Klein 2004). International law has not granted or denied a machine's right to unit self-defense. An exception to this could be applied if the UAV was considered national property, equipment that is essential for mission accomplishment or a strategic asset. The U.S. Air Force uses this classification when operating their UAVs in a reconnaissance role in the Arabian Gulf (Singer 2006, 407).

One internationally recognized ground for preemptive self-defense is in response to banned weapons. The 1907 Hague Convention required free-floating mines to disable after one hour (UNIDR 2015, 4). Free-floating mines that do not disable after one hour are banned by international law (Sparrow 2015, 723). Also, international law says that states do not violate neutrality by clearing mines laid in violation of international law (International Institute of Humanitarian Law 1994, para 92). Essentially, in the case of internationally banned sea mines, disabling them is legal. If certain types of UAVs or their payload were banned weapons under international law, there would be a legal argument for shooting them down.

Preemptive Self-Defense against Terrorist Unmanned Aerial Vehicles

As stated previously, Article 51 of the UN Charter is so limited in authorizing use of force it could be considered obsolete in the face of interstate terrorist organizations. Terrorists are simply too difficult to identify and to anticipate. When factoring in that UAVs are dual use machines, meaning they are used for military and civil purposes, combatting terrorist UAVs becomes even more difficult (UNIDR 2015, 10). Fortunately, international law does recognize states' right to self-defense against terrorist. Following 9/11 there was widespread agreement that Article 51 could be interpreted in that manner (UNODA 2015, 22; Bethlehem 2012, 5).

Determining the target of an act of self-defense can be difficult when dealing with terrorism because UAVs are hard to attribute. A terrorist operating a UAV will most likely fly it from a sovereign state's territory. This can make a state attributable for a terrorist act if the terrorist attack was sent on the behalf of a state, a terrorist entity acted on the behalf of a state, or if the state adopts the terrorist act as its own (Henderson 2010, 140). This harboring standard of attribution was the grounds for use of force in Afghanistan against the Taliban who had harbored Al Qaida. This policy was internationally accepted. It was the first time the North Atlantic Treaty Organization's collective self-defense provision was activated. The UN Security Council also recognized this right with Resolution 1368 (Henderson 2010, 156). Another instance of U.S. use of force in response to terrorism was after the Nairobi and Dar Es Salaam U.S. Embassy bombings. The United States launched cruise missiles at terrorist training camps in Afghanistan and a pharmaceutical plant in Sudan. This strike was justified because passive support had been given to Al Qaida, and those countries had not carried out due

diligence to eradicate non-state entities from operating from within their borders (Henderson 2010, 142, 149).

Establishing that states can be held accountable for terrorist attacks originating from within their territory is half of the argument for authorizing preemptive self-defense against terrorists. This does not actually provide a legal means of preemptively defending one's unit, Webster's rule only provides for preemptive self-defense when the threat is immediate. This is problematic when the threat is a UAV, because it is often impossible to know the intentions of a machine. To prevent an adversary's armed attack requires a commander to determine hostile intent. A terrorist's armed UAV would not demonstrate hostile intent in the traditional sense prior to carrying out the hostile attack. The right to preemptive self-defense must be expanded when operating off the coast of countries unable or unwilling to prevent, or even promote, the use of their territory for terrorist attacks (Sofaer 2003, 1). In this situation, it would be hard to identify a UAV as belonging to the state or a terrorist organization fast enough, and would rightfully assume the UAV represents the more dangerous threat.

A comparable situation to the terrorist threat includes pirates and hijackers. The 1982 UN Convention on Laws of the Sea permits every state to seize pirate ships or aircraft in international waters regardless of the flag displayed. Treatment of terrorists could go in a similar direction (Bunn 1986, 338). International hijacking laws also allow for all interested states to arrest and prosecute offenders for the purpose of denying terrorist sanctuary.

In summation, the use of force for preemptive self-defense against terrorist UAVs is widely accepted by the international community. The difficulty is not in acceptability.

It is in correctly determining which UAVs are operated by terrorists and which are not. Combining the harboring standard with laws concerning preemptive self-defense can mitigate this problem.

Review

The second subordinate thesis question is: can safety of flight or protection of a high value unit from possible terrorist threats justify the preemptive destruction foreign nation's unmanned assets? The answer is sometimes. Preemptively destroying UAVs over the aircraft carrier may be prudent in many cases, but it contradicts the U.S. Air Force's practice of categorizing UAVs as national property. Webster's rule on preemptive self-defense is a good starting point, but as technology advances and warfare becomes faster and more destructive, international law must mature with respect to growing threats such as UAVs. The arguments for banning attacks with UAVs covered in chapter 2 are numerous and convincing. However, their use is currently tolerated and the United States is the number one user of this technology.

On one hand, the purpose of international law, naval regulations, and rules of engagement are to prevent aggression and the outbreak of hostilities, and limit escalation (Bunn 1986, 335). On the other hand, well-used preemption is a legitimate aspect of states' right to self-defense. The decision to use preemptive force is complex and requires a comprehensive decision. Preemption should be determined on a case-by-case basis (Sofaer 2003, 226).

Rules of Engagement against Unmanned Aerial Vehicles

This fourth major area of research addresses the primary research question for this thesis: should ROE allow for authorization of hard-kill and soft-kill options against UAVs for commanders in international waters, territorial waters, and international straights in peacetime? Based on the knowledge gained from answering the subordinate research questions and UAV threat analysis there are eight situations where ROE kill authorization are legal, acceptable, and suitable. The ability to kill a UAV will need to overcome the difficult hurdles of detection and identification. Many of the situations require accurate and specific intelligence. Additionally, a commander is required to exhaust all actions short of use of force prior to engagement when feasible (UNODA 2015, 23).

Situations

1. Hostile act or demonstrated hostile intent by a UAV: this is the easiest ROE authorization because the Chairman of the Joint Chiefs of Staff Instruction 3121.01, Subject: Standing Rules of Engagement for U.S. Forces," makes self-defense in response to a hostile act or demonstrated hostile intent an obligation (Director Joint Staff 2012, III-10). This also complies with Article 51. Another justification would be failure to see and avoid collision with another aircraft according to the ICAO Rules of the Air in the case of a civil UAV (Ells 2014, 342). Examples of hostile acts or intent demonstrated by a small UAV include sustained flight on a launch or approach path to an aircraft carrier, or the launching of an autonomous loitering munition such as the

Harpy. A hard-kill would be recommended with no restrictions for geographic location.

2. Chemical or biological agents: if intelligence determines that UAVs in the CSG's area of operation have been armed with chemical or biological agents, the risk of shooting down an innocent civilian UAV or a state's UAV is out-weighed by the risk of an overwhelming attack. This would be a classic application of Webster's rule for preemptive self-defense (UNODA 2015, 24). Depending on the proximity of the UAV to the carrier at the moment of engagement, a soft-kill engagement consisting of the control signal hijacking of the adversary UAV may be advantageous to prevent dispersal of agents from an explosion in a close in situation. However if time does not allow for this method, a hard-kill is recommended. There are no restrictions for geographic location.
3. Terrorist operated UAVs: if intelligence determines that terrorist organizations possessing armed UAVs are within operational range for the UAV's capability of the carrier strike group, kill authorization against UAVs approaching the strike group identified as unknown, suspect, or hostile could be engaged. If the terrorist organization is assessed to have the capability or desire to launch UAVs from a maritime platform, this needs to be accounted for in range determination. ISIL and Hezbollah are known to possess armed UAVs. Acceptability and legality for this is supported by the *National Security Strategy* and post-9/11 interpretation of Article 51 (Henderson 2010, 192; Streetly 2015, 22). A hard-kill engagement is preferred close in; a soft-

kill method may be preferable at a large engagement range to enable a forensic analysis of the weapon to determine attribution. These engagements should not take place in territorial waters of another state during innocent passage.

4. Pirate-operated UAVs: the UN Convention on Laws of the Sea authorizes seizure of any pirate-operated aircraft (Bunn 1986, 338). A soft-kill method that avoids destruction of the UAV is recommended. This is restricted to international waters.
5. UAVs engaged in electronic warfare: a UAV engaged in electronic warfare against the CSG has committed a hostile act and could be part of a SEAD mission. The *Jus ad Bello* concept of proportionality suggests a soft-kill engagement utilizing EA to defeat the UAV (Director Joint Staff 2012, III-11). This ROE authorization should be limited to international waters.
6. Swarm of UAVs: if a swarm of UAVs is detected approaching the CSG and their identification is unknown, a commander must determine the nature and magnitude of the threat (Sofaer 2003, 220). A swarm could indicate a sophisticated coordinated attack or an attempt to deplete the strike group's air defenses prior to a follow-on attack with more capable weapons (Springer, 2013, 51). Conversely, some states use swarms of small boats to harass naval vessels. If an armed response is deemed necessary, enough air defense missiles should be retained to defeat a follow-on attack. ROE calling for a combination of hard-kill and soft-kill methods is the recommended

engagement in order to defeat the highest number of UAVs. There are no geographic restrictions for this situation.

7. Civilian operated armed UAVs: if intelligence determines that armed UAVs are being operated by civilians, those civilians are illegal combatants under international law and shooting down their weapon would be legal and acceptable if their UAVs are positively identified approaching the strike group (Rogers and Hill 2014, 77). The need to correctly identify with a high degree of certainty the armed UAVs in this situation is very important. Because of the difficulty in determining a UAVs operator, a soft-kill engagement is recommended. A geographic restriction of international waters is also recommended.
8. UAV with neutral markings but exhibiting enemy characteristics: according to the *San Remo Manual*, an aircraft with neutral markings but exhibiting enemy characteristics may be intercepted and diverted to a suitable airfield for visit and search (International Institute on Humanitarian Law 1994, para 115). If an airfield is unavailable, the aircraft may be diverted to an airfield other than its destination. An example of a UAV fitting this description would be one that is suspected of conducting ISR for prolonged periods of time or on repeat occasions. The recommended ROE would not include hard-kill, but would recommend a soft-kill control signal hijacking of the UAV to effect its diversion. This ROE is recommended only for international waters to prevent the violation of a state's sovereignty.

Summary and Conclusion

Chapter 4 began with an analysis of the small UAV threat specific to the CSG. It was broken down into determining what roles were advantageous to UAV use, current and likely state actor use, and current and likely non-state actor use. The research determined that small UAVs are a present and growing threat to the CSG due to their characteristics and the roles they excel in such as bypassing perimeter defense, SEAD, and chemical and biological agent employment. State and non-state actors will use small UAVs in distinct and specific ways.

The second major research area addressed the concepts of see and avoid and due regard in order to determine if UAVs could be operated legally in international waters in the vicinity of the carrier strike group. Addressing the first subordinate research question, this research determined that UAVs cannot be operated legally in international waters in the vicinity of the carrier strike group. It also determined that ICAO regulations are inadequate when addressing UAVs and that no system can currently replace a human's ability to detect and avoid other aircraft.

The third major research area focused on the second subordinate research question regarding whether protection of a high value unit from possible terrorist threats justifies the pre-emptive destruction of foreign nation's unmanned assets. This was the most extensive area of study and was broken down into the sections of self-defense, preemptive self-defense, and self-defense against terrorist UAVs. The answer was that justification for pre-emptive self-defense is situation dependent. It is important to state that since the United States is the biggest user of UAVs in the world, legal arguments limiting their use would reduce the military capability of the United States.

The final major research area answered the primary research question regarding when commanders should be given kill authorization in the ROE against UAVs. The previous research answering the subordinate questions was used to formulate eight very specific situations where hard and soft-kill authorization would be legal, acceptable, and suitable for the specific geographic areas of international waters, territorial waters, and international straits.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Recommendations

The genesis of the primary research question was from the author's personal experience as a Tactical Action Officer onboard USS *Harry S. Truman* during a deployment to the Arabian Gulf during which the carrier was overflown by the UAV of another state. This was a frustrating experience because the UAV managed to get overhead undetected. Discussions were held in the wardroom about whether or not to shoot down the UAV. Although these were not serious discussions, they did serve to illuminate the serious point that there is not a lot of official guidance on counter-UAV warfare. The real purpose of this thesis was to conduct formal research about UAVs, counter-UAV warfare, and preemptive self-defense of the carrier strike group against this emerging threat still in its infancy. The results of this research regarding rules of engagement for commanders in international waters against UAVs should serve as a starting point toward a more comprehensive counter-UAV policy.

The primary research question was: should rules of engagement allow for authorization of hard-kill and soft-kill options against UAVs for commanders in international waters, territorial waters, and international straights. The research concluded that there are eight specific situations where kill authorizations are warranted: hostile act or intent by a UAV; suspected biological or chemical agent employment by a UAV; suspected terrorist employment of UAVs; UAV employment by pirates; UAVs employed in electronic warfare; a UAV swarm; civilian operation of armed UAVS; and UAVs neutrally marked exhibiting enemy characteristics. They are organized by the seriousness

of the threat. This list should not be interpreted as all-inclusive; they are simply the situations research highlighted during the process. A key recommendation is to continue to advance the research and discussion on adversary UAVs which represent a new warfare area and distinct from traditional air defense.

Relationship to Previous Studies

Most DOD studies and doctrine concerning UAVs focus on employment, not countering them as a threat. Generally, this thesis is related to the entire body of UAV literature by specifically addressing a narrower UAV topic, counter-UAV warfare. Additionally, counter-UAV warfare is a niche subset of the broader air defense warfare area. This thesis focused on the specific issue of defense of the CSG against the small UAV threat.

Due to the accelerating nature of UAV and robotic technology, several authors have explored the possible applications of UAVs in future warfare. Futurists, such as Peter W. Singer, have written about the current and future capabilities and threats from autonomous robots. The conclusions reached in this thesis relate mostly to the current and near-term threat from UAVs. Future capabilities enabled by artificial intelligence and swarm behavior covered by Paul Scharre will require a more in-depth analysis and represents an important area for further study.

This thesis does build on the work done by other thesis authors. Many of those theses served as warnings that UAVs are a growing threat and challenge the current paradigm of air superiority that the U.S. military operates under today. They include Robert Bunker, Lieutenant Colonel Jason Earley, and Major Darin Gaub. Their work provided the basis for the assumption in this thesis that UAVs are a threat that must be

countered while this thesis extends the examination of this issue to suggest more precisely when and where reactions to UAVs are warranted.

Another way to relate this thesis to other studies is through the framework of DOTMLPF-P for approaching new issues or problems. Using this approach, this thesis has yielded suggestions for policy, specifically on rules of engagement. Contractors fielding new counter-UAV weapons and military exercises, such as Black Dart, have worked on the employment of material solutions. On the battlefield, policy and material solutions go hand in hand. Undoubtedly, comprehensive doctrine will eventually combine these two areas.

Suggestions for Further Research

This thesis focused on the policy component of the DOTMLPF-P framework. Military contractors are very active in developing material solutions to the counter-UAV warfare area. One area requiring further study is analysis and comparison of the effectiveness of different methods for countering UAVs. How effective is the close-in weapons system at detecting and engaging UAVs compared to an EA method such as jamming or control signal hijacking? This would be a very technical topic.

Another idea for future study surfaced when attempting to research ICAO regulations specific to UAVs. There are very few. A comparison study of the regulations of different countries could yield recommendations for future ICAO regulations on UAVs.

Terminology and categorization is another problem when researching UAVs. UAVs are often times referred to as drones or unmanned aircraft. It is easy to become confused when reading about U.S. DOD UAS group categorization and treaties on non-

proliferation referring to Category 1 and 2 UAVs. Specific terms categorized by size, capability, or level of autonomy might be advantageous. Research to catalog all the different terms and classifications for UAVs could lead to development of a standard terminology. These terms could be codified by an international organization similar to how industry sets standards during international conferences.

Lastly, small UAVs are really not a revolutionary new threat from an air defense perspective. They are new and unique, but conducting counter-UAV operations is more similar to engaging and defeating small, single engine, aircraft from the past than modern supersonic missiles or stealth aircraft. In some ways counter-UAV is devolution for air defense. A re-analysis of pre-World War II air defense as a case study for future counter-UAV warfare could provide some unique insights regarding how to deal with this threat. How soldiers detected and communicated track information on adversary aircraft during World War I may be of some use today against UAVs considering they are hard to distinguish on radar. In those early days of air defense, cover and concealment was a significant consideration. Considering how inexpensive small UAVs are, a more affordable retro approach may suggest appropriate and more sustainable methods for countering them in combat.

Conclusions

ROE should allow for engagement of UAVs under very specific circumstances. The threat from UAV attack on the CSG will continue to grow in volume and lethality as the technology and methods of use mature. The Navy needs to be ready because the future with armed, autonomous, and artificially intelligent UAVs is a scary place. Developing a UAV specific ROE is one way to get ahead of the problem.

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